Lab #7: Using Dichotomous Keys

Introduction:

With over one million described animals on the planet, it is virtually impossible for any one person to remember them all. For those scientists that study organismic biology, most end up becoming specialists on a specific taxonomic group. For example, here in southern California there are experts that focus entirely on burrowing marine worms, flower-loving bees, or shell-less slugs. Even in these seemingly narrow areas of study, the diversity can still be impressively high. So how do ordinary field biologists successfully identify organisms if they don't have an intimate knowledge of these taxa? Fortunately, in many cases (although certainly not all), experts have developed flow charts, known as “dichotomous keys”, to help other scientists successfully identify a species that might be unknown to them. This type of key consists of a series of choices that leads the user to the correct name of an unknown organism. "Dichotomous" means "divided into two parts." Therefore, dichotomous keys always give two choices in each step. These keys will begin with general characteristics and lead to couplets indicating progressively specific characteristics. If the organism falls into one category, you go to the next indicated couplet. By following the key and making the correct choices, you should be able to identify your specimen to the indicated taxonomic level.

Procedure:

For this activity, we will be using insects as our unknown organisms. Insects are ideal model organisms since pinning easily preserves them and allows for examination of their morphology without necessarily observing them in the field. In addition to convenience, insects are incredibly diverse and possess easily identifiable traits such as body segments, wing number and pattern and mouthparts. You will be given a small collection of insects to use as your unknown organisms and below you will find a simple dichotomous key that will allow you to identify the order to which each of the specimens in your collection belongs.

Tips for Using Dichotomous Keys:

When you follow a dichotomous key, your task becomes simpler if you adhere to a few simple rules of thumb:

1. Read both choices in a couplet carefully. Although the first description may seem to fit your sample, the second may apply even better.

2. Keep notes about the sequence of steps you took. This will allow you to check your work later and identify where possible mistakes were made.

3. If you are unsure of which choice to make in a couplet, follow both options (one at a time). After working through a few more couplets, it may become apparent that one path does not fit your specimen at all.

4. When you have keyed out an organism, do not take your effort as the final result. Double-check your identification scheme, using your notes. Find a type specimen (if available) and compare your unknown to the type specimen. If a type specimen is unavailable, find a good description of the indicated taxonomic group and see if your unknown reflects this description.

5. When reading a couplet, make sure you understand all of the terms used. The best keys will have a glossary of technical terms used in the key.
Basic Insect Anatomy

Insects are a sub-phylum (Hexapoda) of invertebrates within the Phylum Arthropoda and are distinguishable by a three-part body plan that includes the head, thorax and abdomen. (Fig. 1) Insects also possess a chitinous exoskeleton, three pairs of jointed legs (if your organism has eight or more legs, you do not have an insect!), compound eyes and one pair of antennae. Wings may or may not be present and occur in either one or two pairs originating from the thorax. Insect wings are quite diverse and many orders are characterized by special anatomical features of their wings (Fig. 2). Insect mouthparts can be quite intricate, with specialized structures suited for their specific feeding habits. Given how specific they are, mouthparts are often included as a couplet tool for keying insects (Fig. 3). Does your specimen have mandibles, a beak or a tube-like feeding structure? Familiarizing yourself with all of these traits will allow you to easily work through the key and arrive at the correct insect order.

Figure 1. Insect body plans for a wasp (top) and a beetle (bottom).

Figure 2. Special features of common insect wings

Figure 3. Mouthparts in a variety of insects.
Dichotomous Key Of Insect Orders:

1. Wings well developed (at least more than half the body length) 2
   Wingless, or with small undeveloped wings (shorter than half the body length) 14

2. Front wings (elytra) hard, leathery, at least at base; hind wings if present, membranous (transparent) 3
   Forewings (front wings) entirely membranous 7

3. Sucking mouthparts with beak longer than wide, and usually jointed 4
   Chewing mouthparts 5

4. Beak arising from front part of head; front wings usually leathery at base and membranous at tip; tips overlapping 1
   Beak arising from rear underside of head, often appearing to arise at base of front legs, front wings of uniform texture, tips not overlapping 2
   Hemiptera
   Homoptera

5. Abdomen with forceps-like cerci (sharp extensions near tail); elytra short, leaving most of the abdomen exposed 1
   Abdomen without forceps-like cerci, wings cover most, if not all of the abdomen 6
   Dermaptera

6. Front wings without veins, usually meeting in straight line down middle of back; antennae with 11 or fewer joints 1
   Front wings translucent with veins, front legs come together in “praying” position 2
   Coleoptera
   Mantodea

7. With 2 wings 1
   With 4 wings 8
   Diptera
8. Hind legs longer than abdomen; pronotum extending back over abdomen, pointed at tip; hind legs enlarged
   __________________________________________________________________________Orthoptera

   Body not grasshopper-like; pronotum not as above; hind legs not enlarged ________________ 9

9. Abdomen with threadlike or spine-like tails; mouthparts small or underdeveloped;
   __________________________________________________________________________10

   Abdomen ovate; mouthparts prominent;___________________________________________11

10. Halteres present and hook-like; wings with only one forked vein; antennae long and conspicuous __Homoptera

   Halteres absent; wings with many veins and cross-veins; antennae short and bristle-like ____Ephemeroptera

11. Wings completely covered with fine scales (use a dissecting scope); mouthparts elongate, coiled tube-like beak
    or tongue __________________________________________________________________________Lepidoptera

   Wings not covered with scales; mouthparts not in coiled tube ________________________12

12. Hind wings connected to forewings with small hooks (hamuli); antennae jointed and conspicuous; fewer veins
    in hind wings than forewings; abdomen usually narrow at base, pincer-like mandibles _______Hymenoptera

   Hind wings not connected to forewings with small hooks (hamuli); wings with many veins and cross-veins
   __________________________________________________________________________13

13. Antennae short and bristlelike; wings with many veins and cross-veins, never held flat over abdomen at rest;
    body long and slender, ¾ to 3 ½ inches long________________________________________Odonata

   Antennae long and conspicuous, usually with 12 or more joints. Front wings with veins, either held roof-like
   over abdomen or overlapping over abdomen_________________________________________Orthoptera
14. Body laterally flattened (side-to-side); lacking wings; parasitic on animals ________________ Siphonaptera

Body flattened dorso-ventrally (top to bottom); not jumping insects ________________ Mallophaga

15. Abdomen very thin, small or narrow at base; antennae usually elbowed; hard bodied ________ Hymenoptera

Abdomen not particularly thin at base; antennae not elbowed; soft-bodied, insect 5/16 inch long or less ________________________________ Isoptera
Dichotomous Key to Common Hymenopteran Families:

1. Wings present ........................................................................................................ 2
   Wings not present ..................................................................................................... 9

2. Abdomen narrowly connected to thorax, giving a “thread-waist” appearance; body relatively hairless; slender body with long spiny legs ....................................................................................... 3
   Abdomen not connected to thorax in a thread-waist manner; body may or may not be hairy 4

3. Body all black or black with yellow or red markings; middle tibiae with 2 apical spurs _______ Sphecidae
   Body dark steely blue with orange wings; middle tibiae with one or two apical spurs _______ Pompilidae

   Figure 1. Single (left) and two (right) apical spurs on metatibiae

4. First discoidal cell of forewing more than half of wing length ___________________________ Vespidae
   First discoidal cell of forewing less than half of wing length ____________________________ 5

   Figure 2. Very long 1st discoidal cell in hymenopteran wing

5. Hindwing with no closed cells; many pits on surface of relatively hairless body; body metallic green or blue__________________________________________________________ Chrysididae
Hindwing containing closed cells; body with at least some hair; body color variable

6. Forewings contain two submarginal cells; ventral side of abdomen with pollen-collecting hairs __Megachilidae

Forewings contain three submarginal cells; ventral side of abdomen lacking pollen-collecting hairs _______7

7. Forewing with strongly arched basal vein; body usually metallic, small to medium body size _______Halictidae

Forewing without strongly arched basal vein ____________________________________________8

8. Second submarginal cell in forewing distinctly smaller than first and third submarginal cells ____Andrenidae

All submarginal cells of relatively similar size _____________________________________________Apidae

9. Antennae elbowed; body relatively hairless ___________________________________________Formicidae

Antennae not elbowed; body covered in dense white, red or orange hair _____________________Mutillidae

Figure 3. Three (left) and two (right) submarginal cells indicated by “SM”

Figure 4. Arrow indicated strongly arched basal cell in Hymenopteran wing
Post-Lab Questions:

1. What is the purpose of a dichotomous key and how is it used?
2. Why are insects easily identifying through the use of a dichotomous key?
3. What are the advantages and disadvantages of using a dichotomous key?
4. What kinds of traits are used to create a dichotomous key? What would be an example of a trait that would NOT be suitable for a dichotomous key?
5. What kinds of organisms might be difficult to identify through the use of a dichotomous key?
6. List a few different techniques that may be used instead of a dichotomous key or to complement the use of one to identify unfamiliar organisms.